underruns and lifts up the warm, moist, southerly wind. Centrifugal force drives the denser cold air toward the equator, pushing the lighter, warm air out of its way, and forcing the latter upward and backward toward the polar regions. These are the principal mechanical conditions that give rise to the winds and clouds that precede such tornadoes as those in northern Mississippi on April 8–9 and 18–19, 1894.

On both these dates a cold, dry, northwest wind was advancing southward over the State as the front edge of an area of high pressure, while warm southerly winds were prevailing everywhere to the southward and eastward. The northwest winds were much stronger than the southerly winds, but they, themselves, did not constitute a tornado, nor could they have done the damage described without another auxiliary process. At the front of the area of northwest wind, where it ran under the south wind and lifted it up, as the nose of a plow lifts and turns the sod, there was formed a cloudy mass due to the rapidly uprising air. The buoyancy within such a cloud is very great. When once well formed, it may suck up the air beneath it with such violence as to form a waterspout over the ocean or a tornado over the land and the winds immediately below it are suddenly and greatly increased. It is these winds under the tornado cloud that do most of the destruction; they start toward the cloud as increasing northwest and south winds on the two sides of the track, but rapidly become deflected into circulating winds, under the cloud, extending sometimes even down as low as the ground itself. The individual clouds and whirls along the front of the northwest wind depend very much upon local irregularities, hills and valleys, rivers and ponds; in some cases there may be a long series of whirls simultaneously existing; at other times only one or two acquire any prominence; again, it may be as suggested by Dr. Duke, that there is an advancing front for the southerly winds as well as for the northwesterly, and that the whirl exists only at the one vertex where these two fronts intersect. All these and other cases may occur; but the last is certainly the least common because there is almost always a steady flow of southerly winds over a very large area of country and the front of the northwest wind is everywhere penetrating this and pushing under it simultaneously so that the southerly front has no independent existence.

We can not agree with the suggestion that there is a strong attraction between the northwest and the south winds, or that there is any neutralization of affinity; the winds represent simply two masses of air driven along the earth's surface by the pushing forces that are at work everywhere in the atmosphere and which are ultimately resolvable into two elementary forces, the attraction of gravitation and the centrifugal force of bodies that revolve with the diurnal rotation of the earth. These two forces will cause warm, moist air to push northward while cold, dry air is pushed southward and the tornadoes start in the narrow belt where the northerly winds push against the southerly.

In many cases a tornado involves a large mass of cloud and may be properly said to move bodily for quite a long distance along the earth's surface, as shown by its path of destruction. At other times a tornado rapidly dies out, but only to be quickly succeeded by another, so that the path of destruction is due to a series of newly-formed successive whirls. The axis of the whirl is oftentimes very much inclined to the earth's surface and it is possible that we may have violent whirls with horizontal axes; but they could not last very long.

METEOROLOGY IN FRANCE.

The Annals of the Central Meteorological Bureau of France for the year 1896 have lately been received at the Weather Bureau Library, published as usual in three volumes, of which the first is devoted to special memoirs and the annual report of the president of the Meteorological Council. From the latter it appears that 18 of the provinces of France publish monthly bulletins, and 34 publish annual bulletins relative to meteorology and climatology. There are 2,045 stations for regular observations, or 1 for every 100 square miles of area, and these have furnished 3,348 special thunderstorm bulletins, which latter have been discussed by Fron, who has, for many years, been devoted to thunderstorm work. The number of thunderstorms reported on each day of the year is given in a table on page 38, from which we take the monthly number as given in the second column of the following table:

Months.	Number of days with thunderstorms.			
	France.	Florida.	Louisiana.	Missouri.
January	4	5	7	1
February	5	8	11	3
March	25	6	12	7
April	25	6	10	23
May	31	22	20	26
June	30	29	24	26
July	31	28	24	26
August	30	31	28	25
September	29	26	19	25
October	29	9	10	13
November	14	8	13	8
December	13	1	7	7
Totals for year	266	179	185	190

The area of France may be taken at 204,000 square miles, or about twice as large as either Arizona, Nevada, Colorado, Oregon or Wyoming; but, of course, it would not be proper to divide the above number of thunderstorm days in France by 2 in order to compare its frequency of thunderstorms with those of these respective States. The only States that approach France in the frequency of thunderstorms are Florida, Louisiana, and Missouri, whose areas are, respectively, 59,000, 41,000, and 65,000 square miles. The number of days on which thunderstorms were reported in these States during 1896 are, for the sake of comparison, given in the above table; they are quoted from page 496 of the MONTHLY WEATHER REVIEW for that year. It is difficult to make any proper comparison between France and these States as to the absolute number of thunderstorm days, but it is proper to compare the annual curves of frequency, and to say that the annual distribution of thunderstorms is much more uniform in France throughout the year, and especially from March to October than it is in any region of the same area on this side of the Atlantic.

This first volume contains also a most important memoir by Prof. Marcel Brillouin on the formation of clouds between contiguous layers of winds; a memoir of 100 pages which the present Editor has undertaken to translate entire for the use of observers and students in America. This memoir can not be successfully condensed; every page contains the solution of some important problem. It represents the first successful effort to apply the views of von Helmholtz and von Bezold to the explanation of innumerable cloud forms and even the exact determination of the conditions under which they originate.

A general idea of the contents of the memoir may be obtained from the list of the titles of the chapters: I. Von Bezold's theory of condensation by mixtures. II. Superposed horizontal layers. III. An atmosphere in convective equilibrium; subdivision into zones; geometrical explanation of von Helmholtz's theory. IV. Mixture of contiguous zones of clear air. V. Mixture of contiguous zones of cloudy air. VI. Contiguous zones that occupy the whole height of the atmosphere; condition of the highest regions. VII. Contiguous zones; clouds of invasion. VIII. Two cloudy zones;

clouds of invasion; rain and hail. IX. Unstable conditions. X. Two layers of clouds in the same zone. XI. General circulation.

THE CLIMATE OF ATHENS.

The study of local climatology is not as yet pursued in the United States with that detail and thoroughness that characterizes European memoirs. Although some of our older voluntary observers and many of our Weather Bureau stations have by this time accumulated the necessary data, and although the records for some stations, such as Pike's Peak and Colorado Springs, the Dudley Observatory at Albany, and the Central Park Observatory in New York, have been published *in extenso*, yet there is still wanting a discussion of these observations in all their bearings on meteorology, hygiene, agriculture, navigation, and engineering which shall serve as a model treatise on the climate of some American station. Such a model memoir bearing on the climate of Athens has, however, lately been published by Professor Demetrius Eginitis, Director of the National Observatory, in that city, and forms a part of the first volume of its annals. The handsome typography that distinguishes this volume above the ordinary meteorological publications is eminently appropriate to the classic nature of the subject, for we have here for the first time presented a complete picture of the climate of a region whose history and art, ethnology and science have been familiar to the civilized world from time immemorial. We have now for the first time the data needed to carry out investigations into the possible relations between the climate and the development of mankind and the arts that accompany civilization. This latter study, if there be anything in it, we must leave to others, but the general contents of Eginitis' work on the climate of Athens we may give at length as suggesting what may well be done for many American cities. The technical meteorological records which have been summarized in this volume are those by Peytier in 1833–1835; by Fraas, 1836–1841; by Vouris, 1839–1847; Papadakis, 1853–1857; Schmidt, 1858–1884; Kokkidis, 1884–1889; Eginitis, 1890–1896. Since 1847 most of these observations have been made at the Observatory of Athens and many of them have been published, more or less completely, by private enterprise. In fact, many of the original records, having been purchased by Germany, are now deposited for safe keeping in the fireproof buildings at Potsdam. After a brief description of the present topography of the city and its surroundings, and the changes that have taken place, as shown by quotations from classic authors, the director of the observatory publishes fourteen chapters treating successively of atmospheric pressure, temperature, humidity, wind, rain, snow, hail, dew and frost, haze and fog, cloudiness, thunderstorms, evaporation, optical phenomena, temperature of the soil and the water, and the Arago actinometer. Each of these chapters opens with a charming sketch of the ideas and the knowledge that have come down to us from the ancient Greeks relative to the subject in hand and it would surprise the modern scientist to see how near the truth the ancient philosophers attained in respect to many subjects that have only become clear to us since the days of Galileo and experimental philosophy.

The barometric pressures are given by decades and by months deduced from the thirty-six years, 1858–1893, and the results compared with the isobars of Teisserenc de Bort. The monthly and mean annual pressures are given for each hour of observation, 8 a. m., 2, and 9 p. m., as well as the extreme barometric readings for each month during these fifty-four years. The variability of the climate, as represented by the amplitude of the normal variation of pressure between two consecutive daily readings at 2 p. m., is shown by the study of the last fifteen years. The variability is decidedly less that for Paris or Perpignan. This is contrary to the ordinary opinion that the climate of Athens is more variable than the climate of Paris and it is shown that the reason lies in the fact that the atmospheric variations at Athens are frequent but not very decided, whereas, at Paris they are less frequent but much greater. At Athens the weather varies sometimes in the course of the day and even in a few hours, but these habitual variations are small, whereas, at Paris the same kind of weather lasts for a longer time but the disturbances are ordinarily more extensive than at Athens.

The chapter on temperature treats that subject with even more elaboration, occupying forty pages of the volume, and concludes with data illustrating the variability of the climate, especially by the fact that the same date palms and other plants flourish to-day in the same places and to precisely the same extent that they did in antiquity. This was then, as now, the limiting climate, in which the palm occasionally, but not regularly, ripened its fruit. A change of 1° C. would, apparently, have made an appreciable improvement in the cultivation of this fruit, so that, as the author says, it is not likely that the normal annual temperature has changed by this amount in two thousand or three thousand years.

The observation of the humidity of the air by means of the hair hygrometer began in 1839, and the discussion of this subject occupies twenty-four pages of the third chapter, preceded, as usual, by quotations from Aristotle and other classic authors. The winds and general cloud phenomena could be observed by the ancients as well as by the moderns, and the quotations from classic authors are arranged in the fourth chapter, which occupies about thirty pages, in connection with the author's more elaborate discussion of each phase of this subject, viz, the relation of the winds to clouds, rain, thunderstorms, humidity, temperature, pressure, diurnal and annual frequency. The strongest wind at Athens is from the northeast, next to that, the south, and the feeblest wind is from the east. The maximum force of the south wind during the period of accurate observation has sometimes attained 20 to 30 meters per second, and on the 26th of October, 1852, such a south wind overturned one of the columns of the temple of Jupiter Olympus at Athens.

The rainfall is discussed in the fifth chapter, in about thirty pages of text. Even the ancients understood that rain was in some way produced by the condensation of aqueous vapor from the atmosphere, and knew that the quantity of water which falls upon the neighboring mountains, such as Parnassus and Hymettus, was far greater than that which fell at Athens. Although Athens is subject to very long and severe droughts, yet the actual rainfall for successive decades does not vary very much. The normal number of rainy days in any month varies from 1.5 in August, 2.9 in July, to 13.5 in December. The prognostics of rain at Athens have been observed from classic times. Whenever Hymettus is seen covered with clouds, it is considered very probable that it will rain. This often fails, but it is verified often enough to maintain the belief in its efficacy. The altitude of Hymettus is about 1,027 meters; consequently, when clouds are seen around its summit, these can scarcely be the upper cirrus or the medium cirro-cumulus, but must necessarily be the lower clouds—cumulo-stratus or cumulo-nimbus. Such a mountain must, therefore, be considered as a hygrometer that indicates the altitude and nature of the clouds. The connection between rain and the local topography, on the one hand, and the general meteorology of Europe, on the other, is discussed, with a view to explaining the general conditions that cause rain.